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Nuclear Energy University Programs (NEUP) Fiscal Year (FY) 2015 Annual Planning Webinar

Light Water Reactor Sustainability (LWRS) Program

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August 14, 2014

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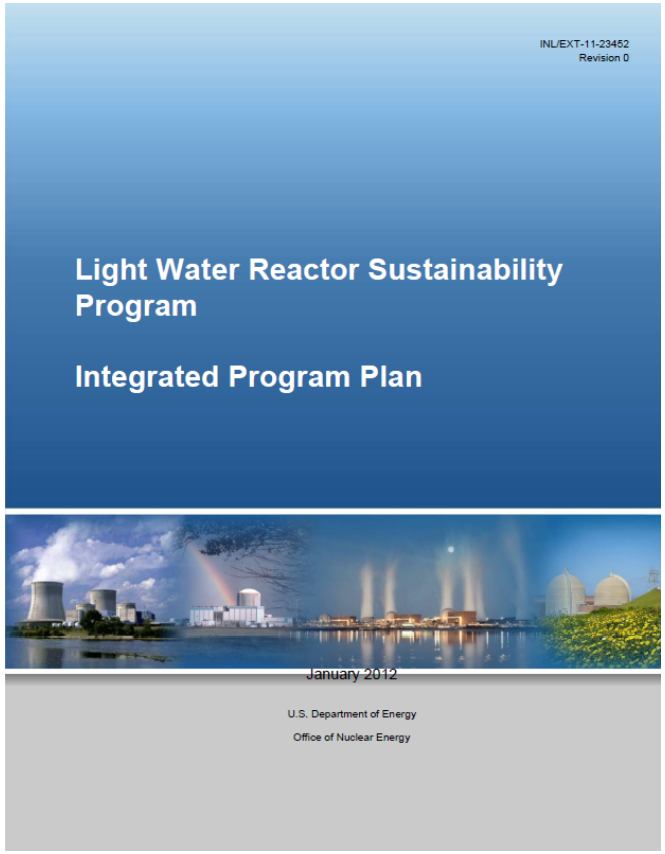
LWRS Vision and Goals

Vision

- Enable existing nuclear power plants to safely provide clean and affordable electricity beyond current license periods (beyond 60 years)

Program Goals

- Develop fundamental scientific basis to understand, predict, and measure changes in materials as they age in reactor environments
- Apply this knowledge to develop methods and technologies that support safe and economical long-term operation of existing plants
- Research new technologies that enhance plant performance, economics, and safety



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Technical Focus Areas Summary

Nuclear Materials Aging and Degradation

- Develop scientific basis for understanding and predicting long-term environmental degradation behavior of materials in nuclear power plants
- Provide data and methods to assess performance of systems, structures, and components essential to safe and sustained nuclear power plant operations
- Develop means to detect and characterize aging degradation processes

Risk-Informed Safety Margin Characterization (RISMC):

- Develop a significantly improved safety analysis tool (RELAP-7 and Grizzly) and a framework (RAVEN) to analyze the safety margin of aging plants.
- RELAP-7 is a “systems” code that will model the whole plant compared to existing codes (including the Hub) that are focused on highly localized phenomena in great detail.
- RAVEN is the simulation controller.
- Grizzly is the component aging and damage evolution model

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Technical Focus Areas Summary

- **Advanced Instrumentation, Information, and Control Systems Technologies**
  - Address long-term aging and obsolescence of existing instrumentation and control technologies and develop and test new technologies
  - Establish a strategy to implement long-term modernization of I&C systems
  - Develop advanced condition monitoring technologies for reliable plant operation
- **Systems Analysis and Emerging Issues**
  - Address high impact emerging issues such as potential backfit of cooling towers
  - Review potential research needs in response to Fukushima lessons learned

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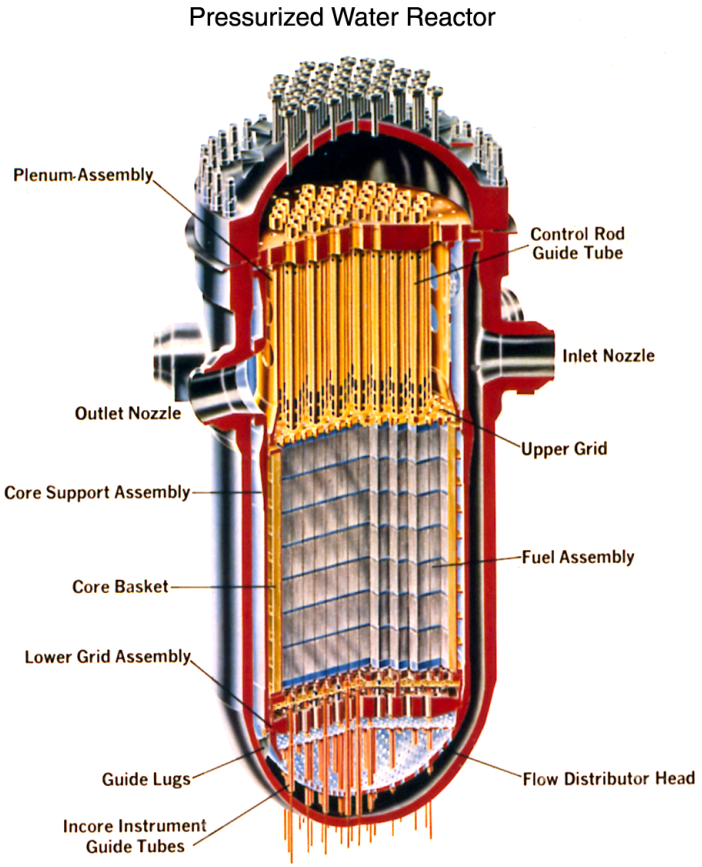
Materials Aging and Degradation

- **Develop the scientific basis for understanding and predicting materials aging and degradation within components, systems, and structures**
  - Reactor metals (RPV's, internals, steam generators, balance of plant, and weldments)
    - Mechanisms of IASCC
    - High-fluence effects on RPV steel
    - Crack initiation in Nickel based alloys
  - Concrete
    - Concrete aging for long term operation
    - Monitoring tools for concrete
  - Cabling
    - Assessment of cable aging issues
  - Mitigation, repair, and replacement technologies
    - Weld repair techniques
    - Post irradiation annealing
    - Advanced replacement alloys



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RISMC Pathway Research and Development Topics

- **Margins Analysis Techniques**
  - Develop techniques to conduct margins analysis, including methodology for carrying out simulation-based studies of margin
- **Simulation components of the RISMC Toolkit**
  - RELAP-7
    - Systems code that will simulate behavior at the plant level
    - Advanced computational tools and techniques to allow faster and more accurate analysis
  - Simulation Controller (RAVEN – Risk Analysis Virtual ENvironment)
    - Provides input on plant state to RELAP-7 (including operator actions, component states, etc.)
    - Integrates output from RELAP-7 with other considerations (e.g., probabilistic and procedures information) to determine component states
  - Aging Simulation (Grizzly)
    - Component aging and damage evolution will be modeled in separate modules that will couple to RELAP-7 and RAVEN

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Overview of the RISMC Pathway

- **The purpose is to support plant decisions for risk-informed margins management to support improved economics, reliability, and sustain safety of current NPPs**
- **Goals of the RISMC Pathway are twofold:**
  1. Develop and demonstrate a risk-assessment method coupled to safety margin quantification that can be used by NPP decision makers as part of their safety margin management strategies
  2. Create an advanced "RISMC toolkit" that enables more accurate representation of NPP safety margin

Margin Management Techniques

- Determine methods to model, measure, and maintain margins for active and passive SSCs for normal and off-normal conditions
- Develop techniques to conduct margins analysis, including methodology for carrying out simulation-based studies of safety margins

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Advanced Instrumentation, Information, and Control (II&C) Systems Technologies

- ***Address long-term aging and reliability concerns of existing II&C technologies and develop and test new technologies***
- ***Establish a strategy to implement long-term modernization of II&C systems.***
- ***<u>Need to develop the scientific and technical bases to support safe and efficient plant II&C modernization.</u>***

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Predictive Models for Materials Degradation

- Materials and components under extended service conditions may see very long lifetimes under stress, temperature, corrosive coolant, and/or neutron or gamma radiation fields.
- The Grizzly code (a MOOSE-based application), is under development to provide a RISMC analysis with a simulation of materials degradation.
- Plans for Grizzly include simulation of damage evolution for the RPV, core internals, and concrete support and containment structures subjected to neutrons, corrosion, and high temperatures and pressures.
- In support of Grizzly development, proposals are requested that develop predictive models for key degradation mechanisms relevant to extended service and are MOOSE compatible.
- Materials of interest are concrete, cable insulation, RPVs, core internals, Ni-based alloy piping, and weldments.
- Proposals should include validation and verification activities.

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Computer Vision and Image Processing Technologies

- The LWRS II&C pathway is working with utilities in pilot plant arrangements to develop and demonstrate how computer-based procedures can benefit the operating fleet of NPPs
- Proposals are sought to develop computer vision and image processing technologies that can be used by nuclear power plant field workers.
- Applications of interest include: object recognition; positional accuracy determination; hazard proximity identification; detection of equipment and conditions; and other capabilities that would improve the efficiency, reliability and safety of the field work.